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Agricultural Research on Cotton Fiber and Processing

U.S. cotton is worth about $4 billion a year in value of farm production, which puts it among the top half-dozen field crops in this country. Its value added in processing is multiplied by 10 to 50 times beyond its crop value when it goes into textiles, apparel, and industrial products. Value-added food and feed products from the seed also contribute to the worth of the crop.

But burgeoning imports of cotton textiles and apparel are threatening the survival of U.S. cotton's main customer--the U.S. textile industry. And only 20 percent of the cotton in imported textiles has been grown in the United States.

Meanwhile, the rest of the world is growing more cotton. China has nearly tripled its production in the last 5 years, to over a third of the world's yearly total.

To succeed in this increasingly competitive economic climate, U.S. cotton must be the world's quality cotton, at a cost competitive with the other large-volume producers.

Locations where ARS conducts research on cotton fiber and processing.

The Agricultural Research Service (ARS) is working on several specific research programs to find ways of achieving this cost-competitive quality.

To improve cotton fiber, we are looking for ways to produce cleaner cotton with longer fiber staple length; higher strength; and greater uniformity, in length as well as maturity.

To help the processor lower costs, we are developing technology to produce higher turnout in ginning and we are exploring cost-cutting technology in spinning and dyeing. We are also studying systems, from farm to consumer, to see where and how the production-processing chain can become more efficient.

To aid in the search for new uses and applications, we are exploring new concepts for putting cotton into yarn, cloth, knits, nonwoven fabrics, oil, feed, and food.

Cotton Quality

To increase our chances for achieving the needed improvements in fiber strength and elongation, staple length, uniformity, and cleanliness, we have established a national cotton-quality program. Since we have 20 research groups, at 11 locations, studying various problems bearing on cotton quality, the purpose of the national cotton-quality program is to focus attention on common objectives and make sure the right groups work together to attain them.

Quality improvement starts with measuring and grading the quality variables that the grower will be paid for. So we have

Left--Cotton-wrap yarn and fine glass core, the ingredients for one of the "core-spun" yarns used in fabrics being developed at New Orleans. Right--Computer projection of single strand of cotton fiber to measure fiber maturity by image analysis. (0885X885-23, 0885X880-34)

assigned high priority to the work being done at Clemson, South Carolina, and New Orleans, Louisiana, to come up with high-speed methods for measuring trash, short-fiber content, and fiber maturity. These methods will be made available to the U.S. Department of Agriculture's Agricultural Marketing Service for use in the cotton industry's grading system, if desirable.

Biotechnology and Cotton

Scientists at Texas Tech University in Lubbock, Texas, recently announced that they have succeeded in growing cotton fibers from cells made by tissue culture--completely without a plant. This work is the direct result of a cooperative project with the ARS laboratory in Lubbock.

Little is known about the basic molecular mechanism that controls the growth of the cotton plant and that of the fiber. To help in making the necessary long-term genetic improvements in cotton, we have started a fiber bioscience program at the Southern Regional Research Center (SRRC) in New Orleans. In cooperation with the scientists at Texas Tech, we plan to explore molecular-genetic factors that control fiber growth. This knowledge may then help us to regulate staple length, strength, and other fiber properties in the plant.

Cotton Research at New Orleans

The Southern Regional Research Center in New Orleans houses one of the most complete, integrated sets of laboratories and pilot plants in the United States for research on processing textile fibers into yarn, fabric, and finished textiles.

Scientists there are at work on (1) basic fiber structural investigations, including crystallography, surface chemistry, and physics of cotton fiber; (2) research on high-speed fiber-testing methods; (3) background research to improve quality and cost of processing the fiber in ginning and in the textile plant; (4) new yarn and fabric concepts; (5) improvements in chemical finishing of cotton and cotton blend fabrics; and (6) cotton toxicology problems--cotton-dust lung disease (byssinosis) and aflatoxin (toxic constituent of cottonseed).

Cotton Research at Clemson

The Cotton Quality Research Unit in Clemson is responsible for background research on high-speed methods for measuring cotton properties important to performance. The main aim of this research is to furnish prototype instrument techniques for measuring properties of the cotton fiber rapidly. These techniques could then be incorporated in the high-volume instrument (HVI) systems now being used more and more in characterization of individual bales of cotton. The original high-volume instrument system was the work of the Clemson laboratory more than 10 years ago.

Working in close cooperation with SRRC, the Clemson unit is developing methods for measurement of trash, short-fiber content, and several other key properties. This unit also has a complete fiber-processing facility (patterned after commercial ring-spinning practice) and collaborates with our 11 ginning and genetics laboratories in the practical assessment of new varieties, from the standpoint of mill processing.

Improving Cotton Fiber

ARS scientists at Florence, South Carolina, and Stoneville, Mississippi, have developed improved germplasm that combines increased staple length and tensile strength with premium-range micronaire, a measure of fiber fineness. The program at Florence has been especially successful in combining this high quality with acceptable yields for Southeastern-produced cottons.

At Phoenix, Arizona, ARS developed the Pima varieties grown in Arizona, New Mexico, and West Texas that are the base for the small but important extra-long-staple cotton industry in the United States. These fibers are used in sewing thread and special, high-quality apparel. Recent releases have combined this superior quality with higher yields and shorter, more efficiently harvested plants.

New Cotton-Finishing Technology

Technology for making 100-percent cotton fabrics flame retardant is the direct result of the pioneering work of SRRC since the 1960's. Recent efforts have developed a series of strong, lightweight flame-retardant fabrics for outdoor use.

SRRC has also been the world's premiere laboratory pioneering the chemistry of no-iron and easy-care cotton and blend fabrics. The high quality of cotton textiles finished just about anywhere in the world has its origin in the detailed and exhaustive work done in New Orleans for more than 25 years. Recently introduced no-iron sheets, shirts, and pants--featuring 60-100 percent cotton content--are based on the chemical building stones devised by the SRRC chemists.

Formaldehyde is an essential ingredient in the common resins used for durable-press. Its use has been under attack in recent years because it is seen as an irritant or

Comparing nep content of cotton fiber samples. Measuring and eliminating neps is a vital part of ARS' efforts to improve cotton quality. (0885X889-9a)

Various fabrics under development at the New Orleans lab are being tested for wear and weatherability needed for outdoor use. (0885X892-28)

potential carcinogen. Since 1974, the only nonformaldehyde finish used around the world has been one developed at SRRC. It has been much used in Japan, but it is inefficient and expensive to use.

Recently, scientists at SRRC have developed a resin system free from formaldehyde that is as effective as the common formaldehyde-based systems. The prime ingredient is glyoxal, which is considered nontoxic. Patents have been applied for, and two chemical companies have licensed the process for sale and use if formaldehyde should be excluded by the Environmental Protection Agency or Occupational Safety and Health Administration from practical applications.

Control of Cotton Dust To Prevent Byssinosis

Once regarded as a major deterrent to the use of cotton in textiles, byssinosis has been the object of intensive research by ARS, the National Institute of Occupational Safety and Health, Cotton Incorporated, and industry. A joint task force has managed this effort for the last 5 years.

The problem of cotton dust, which is associated with byssinosis, has been largely solved in current U.S. textile operations through engineering controls and new production equipment in the mills, at a cost to the industry of more than $1.5 billion. But the industry feels that as long as the cotton fiber carries the hazard of byssinosis, we don't have a complete solution.

ARS' research on these problems started in the early 1970's when dust removal and cleaning technologies were developed at the ginning laboratories and at SRRC. Fiber-processing additives were developed at the Clemson Cotton Quality Research Unit and have been used in most mills to suppress dust levels through processing.

The effort of the joint task force points strongly to the conclusion that bacterial endotoxin is the cause of short-time impairment in breathing capacity. These results have come from studies with both guinea pigs and humans. The human studies were done at the Clemson Cotton Quality Research Unit, where a facility has been specially outfitted, and at other locations. Current work is aimed at confirming these studies.

Research to date has clearly demonstrated that washing cotton with water at temperatures above 40°C eliminates almost all of the active ingredient. But the process developed for doing this is projected to cost 12 cents per pound. This is too high an added cost for U.S. textile mills, which have to compete with cheap imports from countries that don't see byssinosis as a problem and which have other labor-cost advantages.

Research is now focused on trying to eliminate the cause of byssinosis in another way, through a lower cost treatment of the fiber or by eliminating the causative factor in the cotton plant in the field before harvesting.